## AMENDMENT TO THE SPECIFICATION

**Please amend the second paragraph on page 13 as follows:**

The present invention wave energy conversion system **100** also include a turbine device **140** attached to the float **110** (or tether **120**) for generating electricity as the float **110** moves through the water.

**Please amend the third paragraph on page 14 as follows:**

The embodiment shown in Figure 3A utilizes a horizontal axis turbine **142** and an electric generator **148** affixed to the tether **120** immediately beneath the float **110**. The entire turbine **142** is free to rotate around a vertical axis so that it can adjust to the shifting directions of the float motion for driving the electric generator **148**.

**Please amend the fifth paragraph on page 14 as follows:**

Another embodiment utilizing a vertical axis turbine **146** is shown in Figure 3C. In this embodiment a 3-cup rotor is placed on a vertical axis, above or below the float **110**, and affixed to an electric generator **148**.

**Please amend the second paragraph on page 16 as follows:**

Referring to Figures 5A and 5B, there are shown two alternative embodiments of the present invention system for shallower water. In the embodiment shown in Figure 5A, the tether **120** is moored to the ocean floor **20** by moorings **132** and **134** at its two opposite ends. The float **110** is affixed to the tether **120** by one or more rollers **170** that allow the float **110** to oscillate horizontally ~~in the direction of wave travel~~. Because the float **110** moves with respect to the tether **120**, it offers a new way of generating electricity by coupling

to the rotation of the rollers **170**. An additional option is to place fixed magnets (not shown) on either the float **110** or the tether **120** and use the other member as a linear generator.

**Please amend the second full paragraph on page 17 as follows:**

As shown in Figure 6, if a deep water installation is desired, it can be accomplished by having the tether branch out below a certain depth to connect to the ocean floor **20** in multiple mooring locations **130** so that the branching point will be held stationary despite the horizontal excursions of the float **110**. This geometry also affords the opportunity to adjust the effective tether length by adjusting the depth as which the multiple tethers join into a combined tether. One mechanism that binds the tethers **120** together may be a moveable "collar" ~~**142**~~ **122**, which can be adjusted, by moving it up or down to change the distance between the float and the tether joining point, to "tune" the entire installation to an ideal geometry depending on changes in the ocean wave characteristics.

**Please amend the last paragraph on page 17 as follows:**

"Tuning" of the installation can also be achieved by other means besides moving the collar on the multi-tether installation. As an example shown in Figure 7, tuning can be achieved by any suitable device, such as an electronic winch **112** powered by an on-board battery **114** through electrical cables **116**, that can adjust the length of the tether **120** beneath the float **100**.

**Please amend the first paragraph on page 18 as follows:**

In some applications it may be desirable to extract wave energy far from shore or in extremely deep water. In these applications it may be impractical to moor the installation to the ocean floor. Nonetheless, the principle of the oscillating float can still be employed by using a counterbalance to act as a virtual

mooring and offset the excess buoyancy of the float **110**. Referring to Figure 8A, there is shown an example of this modification. The counterweight **190** at the bottom of the tether **120** stays relatively stationary due to its inertia. An underwater cable **150** connects the turbine **140** to a receiving vessel **200**. In addition, the counterweight **190** will be at a depth below most of the wave influence and therefore can be stabilized with added fins or some other drag producing device.

**Please add a second paragraph on page 18 as follows:**

Of course the applications for the float-tether-counterweight configuration are not limited to power generation. Referring to Figure 8B, if the float **110** and the counterweight **190** at the bottom of the tether **120** are designed with an asymmetric drag coefficient (*i.e.*, the body has more drag when moving in one direction than moving in the reverse direction), then the entire device will oscillate and tend to migrate horizontally through the water. Hence such a device may be used to tow a vessel **200** using a structural cable **124**, or used simply as a way to move the device to a desired location.

## AMENDMENT TO THE CLAIMS

**Claim 1 (currently amended):**

An apparatus for extracting energy from waves in a liquid body, comprising:

a. at least one ~~floating~~ device placed in said liquid body and having a float with excess buoyancy exerting a primarily upward buoyant force on the float along a direction perpendicular to the isobaric surfaces of the liquid body which changes as said waves propagating through the liquid body;

b. the at least one ~~floating~~ device further having means for holding said float with excessive buoyancy in said liquid body beneath the surface of the liquid body, the holding means exerting a primarily downward holding force on said float while allowing said float to move back and forth in a substantially horizontal direction as a result of a substantially horizontal force which is a combination of the holding force and said buoyant force and changes its direction back and forth in response to fluctuating pressure in the region of said float that is associated with the waves of the liquid body; and

c. means attached to said at least one floating device, including at least one propeller driving an electric generator, for generating electricity as said float moves back and forth in said liquid body.

**Claim 2 (original)**

The apparatus in accordance with Claim 1, wherein said holding means comprises at least one elongated flexible tether.

**Claim 3 (original)**

The apparatus in accordance with Claim 2, wherein said at least one tether is connected to said float at one end.

**Claim 4 (original)**

The apparatus in accordance with Claim 3, wherein said holding means further comprises at least one mooring device connected to another end of said at least one tether.

**Claim 5 (original)**

The apparatus in accordance with Claim 3, wherein said holding means further comprises at least one counter-weight device connected to another end of said at least one tether.

**Claim 6 (original)**

The apparatus in accordance with Claim 2, wherein holding means further comprises a mechanism for interconnecting said float and said at least one tether that allows said float to move back and forth in a substantially horizontal direction.

**Claim 7 (currently amended)**

The apparatus in accordance with Claim 6, wherein said interconnecting mechanism comprises at least one roller pivotally connected to said float ~~and~~ wherein said at least one roller is riding on said at least one tether.

**Claim 8 (original)**

The apparatus in accordance with Claim 7, wherein said holding means further comprises at least one mooring device connected to each end of said at least one tether.

**Claim 9 (original)**

The apparatus in accordance with Claim 1, wherein said holding means comprises at least one substantially horizontal track.

**Claim 10 (original)**

The apparatus in accordance with Claim 9, wherein said holding means further comprises at least one anchoring device connected to each end of said at least one track.

**Claim 11 (original)**

The apparatus in accordance with Claim 9, wherein holding means further comprises a mechanism for interconnecting said float and said at least one track that allows said float to move back and forth in a substantially horizontal direction.

**Claim 12 (currently amended)**

The apparatus in accordance with Claim 11, wherein said interconnecting mechanism comprises at least one roller pivotally connected to said float ~~and~~ wherein said at least one roller is riding on said at least one track.

**Claim 13 (currently amended)**

The apparatus in accordance with Claim 2, further comprising means for adjusting the ~~tension on~~ length of said at least one tether.

**Claim 14 (original)**

The apparatus in accordance with Claim 13, wherein said adjusting means comprises a winch attached to said float.

**Claim 15 (original)**

The apparatus in accordance with Claim 13, wherein said winch is an electric winch.

**Claim 16 (original)**

The apparatus in accordance with Claim 1, wherein said holding means comprises a multiplicity of elongated flexible tethers.

**Claim 17 (original)**

The apparatus in accordance with Claim 16, wherein said holding means further comprises at least one mooring device connected to each one of said multiplicity of tethers.

**Claim 18 (original)**

The apparatus in accordance with Claim 16, further comprising means for joining said multiplicity of tethers at a distance below said float.

**Claim 19 (original)**

The apparatus in accordance with Claim 18, wherein said joining means comprises at least one movable collar device.

**Claim 20 (original)**

The apparatus in accordance with Claim 18, further comprising means for adjusting said distance below said float.

**Claim 21 (original)**

The apparatus in accordance with Claim 20, wherein said adjusting ~~mens~~ means comprises at least one powered collar device.

**Claim 22 (original)**

The apparatus in accordance with Claim 1, wherein said means for generating electricity is attached to said float.

**Claim 23 (original)**

The apparatus in accordance with Claim 2, wherein said means for generating electricity is attached to said at least one tether at a location adjacent to said float.

**Claim 24 (original)**

The apparatus in accordance with Claim 1, wherein said means for generating electricity comprises at least one turbine device.

**Claim 25 (original)**

The apparatus in accordance with Claim 24, wherein said at least one turbine device is a horizontal axis turbine device.

**Claim 26 (original)**

The apparatus in accordance with Claim 24, wherein said at least one turbine device is a vertical axis turbine device.

**Claim 27 (original)**

The apparatus in accordance with Claim 1, further comprising means for transporting electricity generated by said electricity generating means to a power processing facility.

**Claim 28 (original)**

The apparatus in accordance with Claim 1, wherein said electricity transporting means comprises at least one electrically conductive cable device.

**Claim 29 (currently amended):**

A method of extracting energy from waves in a liquid body, comprising the steps of:

a. placing at least one ~~floating~~ device having a float with excess buoyancy in said liquid body such that the excess buoyancy exerts a primarily upward buoyant force on the float along a direction perpendicular to the isobaric surfaces of the liquid body which changes as said waves propagating through the ~~water~~ liquid body;

b. holding said float with excessive buoyancy in said liquid body beneath the surface of the liquid body such that a primarily downward holding force is also exerted on said float, while allowing said float to move back and forth in a substantially horizontal direction, as a result of a substantially horizontal force which is a combination of the holding force and said buoyant force and changes its direction back and forth in response to fluctuating pressure in the region of said float that is associated with the waves of the liquid body; and

c. attaching an electricity generating means to said at least one ~~floating~~ device, including at least one propeller driving an electric generator, for generating electricity as said float moves back and forth in said liquid body.

**Claim 30 (original)**

The method in accordance with Claim 29, wherein said holding step further comprises a step of attaching at least one elongated flexible tether to said float.

**Claim 31 (original)**

The method in accordance with Claim 30, wherein said holding step further comprises a step of mooring said at least one elongated flexible tether attached to said float.

**Claim 32 (original)**

The method in accordance with Claim 30, wherein said holding step further comprises a step of attaching a counter-weight to said at least one elongated flexible tether.

**Claim 33 (original)**

The method in accordance with Claim 30, wherein holding step further comprises a step of interconnecting said float and said at least one tether that allows said float to move back and forth in a substantially horizontal direction.

**Claim 34 (original)**

The apparatus in accordance with Claim 29, wherein said holding step further comprises a step of supporting said float with at least one substantially horizontal track that allows said float to move back and forth in a substantially horizontal direction.

**Claim 35 (currently amended)**

The method in accordance with Claim 30, further comprising a step of adjusting the ~~tension on~~ length of said at least one tether.

**Claim 36 (original)**

The method in accordance with Claim 29, wherein said holding step further comprises a step of attaching a multiplicity of elongated flexible tethers to said float.

**Claim 37 (original)**

The method in accordance with Claim 36, wherein said holding step further comprises the step of mooring each one of said multiplicity of tethers.

**Claim 38 (original)**

The method in accordance with Claim 36, further comprising a step of joining said multiplicity of tethers at a distance below said float.

**Claim 39 (original)**

The method in accordance with Claim 38, further comprising a step of adjusting said distance below said float.

**Claim 40 (original but miss numbered as Claim 39)**

The method in accordance with Claim 29, further comprising a step of providing a power processing facility for conditioning and storage of electricity generated by said electricity generating means.

**Claim 41 (currently amended, originally missed numbered as Claim 40)**

The method in accordance with Claim ~~39~~ 40, further comprising a step of transporting electricity generated by said electricity generating means to said power processing facility.

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## REMARKS

1. This Response to and Amendment After First and Non-Final Office Action made under 37 C.F.R. § 1.111 (hereafter "the Response") is being mailed by United States Express Mail, Express Mailing Label No. EV 255345430 US in a postage paid envelope addressed to Mail Stop Fee Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on September 11, 2003.

2. The shortened statutory period of three (3) months time period for response to the Office Action expired on July 8, 2003. The Applicants have enclosed with this Response a Petition and Fee Extension of Time under 37 C.F.R. § 1.136 to request an extension of time of three (3) month through October 8, 2003 for this Response to be timely filed. Accordingly, this Response is timely filed. In the event that the Commissioner for Patents should determine that any additional extension of time is required for this Response to be timely filed and an appropriate fee is due for that extension of time, then the Commissioner for Patents is hereby authorized to charge Deposit Account Number 18-2222 for such appropriate fee.

3. On August 11, 2003, an Office Interview was conducted in person between Examiners Julio C. Gonzalez and Joe Waks, inventor Thomas Zambrano, and Attorney Tony D. Chen at the United States Patent and Trademark Office (hereafter "the Interview"). An Interview Summary was subsequently mailed on August 15, 2003 (hereafter "the Summary"), requesting the Applicants to file a written Statement of the Substance of the Interview (hereafter "the Statement") within one (1) month from the date of the Interview or the mailing date of the Summary, whichever is later. Therefore, the deadline for filing the Statement is September 15, 2003. The Statement is incorporated into this Response below and therefore is timely filed.

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4. The following is the Statement of the Substance of the Interview:

4.1 During the Interview, one of the co-inventors, Mr. Thomas Zambrano (hereafter "Mr. Zambrano") presented an oral introduction of the invention covered in the ''038 Application, as well as a video presentation of Applicants' proof-of-concept experiments conducted according to the invention.
Mr. Zambrano's oral introduction covered the subjects of contrasting wave, water and float speeds, implementation of the invention, and Applicants' proof-of-concept experiments.
Written outlines of Mr. Zambrano's oral introduction, entitled "Background Briefing", were provided to Examiners Julio C. Gonzalez and Joe Waks at the Interview. A copy of Mr. Zambrano's outline is submitted herewith as **Exhibit 1**.

4.2 The following references were discussed in Mr. Zambrano's presentation:

4.2.1 Tomczak, Matthais: "Introduction to Physical Oceanography" (Ver. 2, Univ. of S. Australia, Adelaide, Sept. 2000), Notes to Chapter 9, reprinted from www.es.flinders.edu.au/~mattom/IntroOc/notes/lecture09 (copyright 1996) (hereafter "*Tomczak*"). *Tomczak* provides a discussion of ocean waves, including the relationship between wave length, height, water depth, wave period, and wave speed, and the description of water particles moving on circles as ocean wave propagates.

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4.2.2 Dean, Robert G. and Dalrymple, Robert A.: "Water Wave Mechanics for Engineer and Scientists", *Advanced Series on Ocean Engineering*, Vol. 2 (Prentice Hall, 1984) (hereafter "*Dean et al.*"). *Dean et al.* provides a discussion of water wave mechanics, including water particle displacement in circular motion (*see e.g.*, § 4.2.2, Eq. 4.13, p. 82; Fig. 4.3, p. 83), the pressure field under a progressive wave (*see e.g.*, § 4.3, Eq. 4.23, p. 83), and the local accelerations under a wave (*see e.g.*, § 4.4.1, Eq. 4.36, Fig. 4.6, p. 87).

*Tomczak* and *Dean et al* are cited on the Information Disclosure Statement by Applicant (Form PTO/SB/08B) submitted herewith. Copies of *Tomczak* and *Dean et al.* are also submitted herewith.

4.3 All pending claims of the '038 Application were discussed during the Interview, as to whether, with the amendment as detailed in this Response, the rejections of such pending claims under 35 U.S.C. §§ 112, 102 and 103 may be overcome.

4.3.1 Regarding the rejections under 35 U.S.C. § 112, the discussions focused on the ocean wave dynamics, particularly the water particles' circular movement, and the pressure field under ocean wave propagation. The teachings of *Tomczak* and *Dean et al.* were further cited as background in support of the Specification and claims of the '038 Application.

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4.3.2 Regarding the rejections under 35 U.S.C. § 112, the discussions also focused on the rotation of propellers caused by the back-and-forth movement of the float. The Applicants agreed to provide additional references to show that the linear movement of a turbine device relative to a fluid body could cause the rotational movement of the propellers of the turbine device, and that in a particular type of turbine device known as the Wells turbine the linear movement of the turbine device relative to a fluid body could cause the rotational movement of the symmetrically profiled propellers in one rotational direction regardless of the linear direction of the relative movement (*i.e.*, both the "back" and the "forth" relative movement between a Wells turbine device and the fluid body would cause the propeller of the Wells turbine device to rotate in the same rotational direction). In this regard, the Applicants hereby submit the following additional prior art references:

4.3.2.1 United Kingdom Patent No. 1,595,700 issued to Wells for "Fluid Driven Rotary Transducer" (hereafter "*Wells*"): This reference by Professor Alan Arthur Wells, the inventor of the original "Wells turbine", discloses a rotary turbine device having a rotor with a plurality of blades. Each blade has an aerofoil cross-section and is fixed with its plane of zero lift normal to the axis

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of the rotor, such that fluid flow in either axial direction can cause the rotor to rotate always in the same direction of rotation.

4.3.2.2 Australia Patent No. 728,906 issued to Doleh *et al.* for "Apparatus for Conversion of Energy from the Vertical Movement of Seawater" (hereafter "*Doleh et al.*"): This reference discloses relative movement of seawater and propellers of a turbine device can cause the propellers to rotate for generating electricity.

4.3.2.3 WIPO Publication No. WO 01/48374 A2 of PCT Application by Gavasheli *et al.* for "Turbine for Free Flowing Water" (hereafter "*Gavasheli et al.*"): This reference discloses a turbine capable of rotation in one direction under reversible fluid flow.

The teachings of *Wells*, *Doleh et al.* and *Gavasheli et al.* provide as background in support of the Specification and claims of the '038 Application, with regards to the rotation of propellers caused by the back-and-forth movement of the float. *Wells*, *Doleh et al.* and *Gavasheli et al.* are cited on the Information Disclosure Statement by Applicant (Form PTO/SB/08A) submitted herewith, and copies of which are also submitted herewith.

4.3.3 Regarding the rejections under 35 U.S.C. §§ 102 and 103, the prior art cited in the Office Action, namely United States Patent No. 4,581,704 issued to Rubi (hereafter "*Rubi*"), United States Patent No. 4,327,296 issued to Weyers (hereafter "*Weyers*"), United States Patent No. 4,754,157 issued to Windle (hereafter "*Windle*") and United States Patent No. 6,531,788 issued to Robson (hereafter "*Robson*") were discussed. For the reasons stated in detail below, the Applicants believe that the pending claims of the '038 Application, as amended herein, are allowable over these cited prior art references.

4.4 At the end of the Interview, no final agreement with respect to the pending claims of the '038 Application was reached.

The above constitutes the Statement of the Substance of the Interview as required by the Summary.

5. In this Response, independent Claims 1 and 29 have been amended, and dependent Claims 2 through 28 and 30 through 41 are retained as they were originally presented. The original '038 Application had forty-one total claims wherein two were independent claims. The '038 Application now has the same number of total and independent claims. However, due to misnumbering of the original claims, the Applicants paid for forty claims. Accordingly, additional filing fee of $9.00 is due and a check for that amount is enclosed herewith. In the event that the Commissioner for Patents should determine that any additional fee is due, then the Commissioner for Patents is hereby authorized to charge Deposit Account Number 18-2222 for the appropriate fee.

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6. The Examiner's objection to the drawings is noted. The Examiner's careful review of the drawing and the Specification is appreciated. Appropriate amendments have been made to the drawings and related paragraphs of the Specification of the '038 Application in order to overcome the objection.

6.1 The Examiner's objections to the drawings concerning missing reference numerals are addressed as follows:

6.1.1 *Figure 1, reference **140***:

The second paragraph on page 13 of the Specification has been amended to recite "a turbine device **140**" shown in Figure 1.

6.1.2 *Figure 3A, reference **142***:

In the original text of the third paragraph on page 14 of the Specification, "turbine **142**" was recited.

6.1.3 *Figure 4B, reference **162***:

The reference numeral **162** and the antenna shaped drawing element pointed by reference numeral **162** in Figure 4B are both deleted therefrom.

A sheet of drawing containing Figure 4B with proposed drawing correction marked in red ink, and a clean sheet of the same drawings after the correction, are submitted, along with a Request for Approval of Drawing Correction concurrently filed herewith.

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6.1.4 *Figure 5A, references **130, 132 and 134***:

The second paragraph on page 16 of the Specification has been amended to recite that "in Figure 5A, the tether **120** is moored to the ocean floor **20** by moorings **132 and 134** at its two opposite ends" as originally shown in Figure 5A. The reference numeral **130** in both Figures 5A and 5B has been corrected to reference numeral **20** which points to the ocean floor. The duplicate reference numeral **120** at the far right end of Figure 5A is deleted.

A sheet of drawings containing Figures 5A and 5B with proposed drawing correction in red ink, and a clean sheet of the same drawings after the correction, are submitted, along with the Request for Approval of Drawing Correction concurrently filed herewith.

6.1.5 *Figure 6, reference **122***:

The second full paragraph on page 17 of the Specification has been amended to recite "a moveable 'collar' **122**" shown in Figure 6.

6.1.6 *Figure 6, references **114 and 116***:

The last paragraph on page 17 of the Specification has been amended to recite "an electronic winch **112** powered by an on-board battery **114** through electrical cables **116**" as shown in Figure 7.

6.1.7 *Figures 8A and 8B, references **124, 140, 150, 190** and **200**:*

Due to a printing error, page 18 of the copy of the Specification submitted when the '038 Application was filed missed the remaining texts of the first paragraph on page 18 after the word "however", and also missed the entire second paragraph on page 18. These missing texts are being added back through this Response, which recited the turbine **140**, the cable **150**, the counterweight **190** and the vessel **200** shown in Figure 8A, and the structural cable **124** and the counterweight **190** shown in Figure 8B.

6.2 The Examiner's Objection to the drawings concerning reference **130** in Figures 5A and 5B is addressed as follows:

Reference numeral **130** in both Figures 5A and 5B has been corrected to **20** which points to the ocean floor. A sheet of drawings containing Figures 5A and 5B with proposed drawing correction is submitted, along with the Request for Approval of Drawing Correction concurrently filed herewith.

6.3 The Examiner's objections to the drawings concerning the showing of the electric generating means and the counterweight are addressed as follows:

Figure 3A and the corresponding third paragraph on page 14 of the Specification have been amended to show the electric generator **148** attached to the tether **120**.

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Figure 3C and the corresponding fifth paragraph on page 14 of the Specification have been amended to show the electric generator **148** attached to the float **110**. No new matter is introduced.

A sheet of drawings containing Figures 3A and 3C with proposed drawing correction in red ink, and a clean sheet of the same drawings after the correction, are submitted, along with the Request for Approval of Drawing Correction concurrently filed herewith.

6.4 The Examiner's objection to the drawings concerning duplicated reference **142** is addressed as follows:

The second full paragraph on page 17 of the Specification has been amended to recite "a moveable 'collar' **122**" shown in Figure 6.

6.5 It is believed that the amendment and response presented herein have overcome the objection to the drawings.

7. The Examiner's rejection of Claims 1–41 under 35 U.S.C. § 112, first paragraph, is noted. The Examiner's careful reading of the Specification is appreciated. The Applicants respond to the Examiner's concern as follows:

7.1 The Examiner's rejection concerning the horizontal movement of the float as described in the Specification is addressed as follows:

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7.1.1 The Applicants respectfully point out that Figure 1 of the drawing did not show that the float would only move vertically. Rather, Figure 1 of the drawing shows force **B** from the buoyancy of float **110** which is perpendicular to the isobaric surfaces **16**, force **T** exerted by the tether **120** on the float **110** along the downward direction of the tether **120**, and the resultant force **F** from the combined influence of the buoyancy force **B** and the tether force **T**. Figures 2A through 2D further show that the resultant force **F** fluctuates with the wave and tether geometries and drives the float **110** back and forth as the slope of the isobaric surfaces **16** change, which occurs as waves cross over the region where the system is moored.

7.1.2 In the second paragraph on page 16, the texts "in the direction of wave travel" have been deleted. The reason that the float can move back and forth is because the resultant force **F** changes its direction with the wave and tether geometries as the slope of the isobaric surfaces **16** change, which occurs as waves cross over the region where the system is moored.

7.1.3 It is believed that the teachings of *Tomczak* and *Dean et al.* provides sufficient background on ocean wave dynamics, the water particles' circular movement, and the pressure field under ocean wave propagation, to support the Specification and claims of the '038 Application.

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7.2 The Examiner's rejection concerning the "tuning" of the "natural frequency" of the system as described in the Specification is addressed as follows:

The term "natural frequency" as used in the Specification refers to the frequency of back and forth oscillation of the float, which can be adjusted by changing the position of the collar **122** which in turn changes the distance between the float **110** and the tether joining point. The winch for adjusting the length of the tether **120** may be controlled manually or by automated programs.

7.3 The Examiner's rejection concerning how the electricity is generated as described in the Specification is addressed as follows:

7.3.1 The Specification has described using turbines and electric generators for generating electricity. It is known that electricity can be generated by an electric generator when it is driven by the rotation of the turbine propellers attached to the electric generator.

7.3.2 As discussed earlier, *Wells*, *Doleh et al.* and *Gavasheli et al.* taught that the linear movement of a turbine device relative to a fluid body could cause the rotation of the propellers of the turbine device, and that turbine devices can be designed such that the propellers always rotate in the same direction regardless of the direction of linear movement of the turbine device relative to a fluid body.

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7.3.3 It is believed that the teachings of *Wells*, *Doleh et al.* and *Gavasheli et al.* provides sufficient background on turbine devices used in energy conversion from the movement of a fluid body relative to the propellers of a turbine device, and particularly the design of turbine devices where the propellers are always caused to rotate in the same direction even though the relative movement between the fluid body and the turbine device reverses its direction.

7.3.4 The purpose of Figure 8A is to show that in some applications it may be desirable to extract wave energy far from shore or in extremely deep water, but it may be impractical to moor the installation to the ocean floor; that the principle of the oscillating float can still be employed by using a counterbalance to act as a virtual mooring and offset the excess buoyancy of the float **110**. The purpose of Figure 8B it to show that the applications for the float-tether-counterweight configuration is not limited to electrical power generation.

7.4 It is believed that the amendment and response presented herein have overcome the rejection of Claims 1–41 under 35 U.S.C. § 112, first paragraph, and therefore these claims are allowable. Accordingly, reconsideration and withdrawal of the rejection of Claims 1–41 under 35 U.S.C. § 112, first paragraph, are respectfully requested.

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8. The Examiner's rejection of Claims 1–41 under 35 U.S.C. § 112, second paragraph, is noted. The Examiner's careful reviewing of the claims is appreciated. The Applicants respond to the Examiner's concern with the claim amendment described as follows:

8.1 In Claim 1, the phrase "at least one floating device" has been amended to "at least one device" which includes the float **110** and a holding means as the holding means may further include the tether **120** and the mooring **130**.

8.2 Claim 6 has been amended to recite that the float moves back and forth in a substantially horizontal direction "as a result of said substantially horizontal force and in response to said fluctuating horizontal pressure gradients associated with said waves of said liquid body".

8.3 Claims 12 has been amended to recite that it is the roller that is riding on the at least one track.

8.4 In Claim 21, the misspelled word "mens" has been corrected to "means".

8.5 Claim 22 depends on Claim 1 and recites the phrase "means for generating electricity". Claim 1 has been amended to recite that the means for generating electricity comprises "at least one propeller driving an electric generator".

8.6 It is believed that the amendment and response presented herein have overcome the rejection of Claims 1–41 under 35 U.S.C. § 112, second paragraph, and therefore these claims are allowable. Accordingly, reconsideration and withdrawal of the rejection of Claims 1–41 under 35 U.S.C. § 112, second paragraph, are respectfully requested.

9. The Examiner's rejection of Claims 1–4, 22, 27–31, 40 and 41 under 35 U.S.C. § 102(b) over United States Patent No. 4,581,704 issued to Rubi (hereafter "*Rubi*") is noted but respectfully traversed.

9.1 *Rubi* disclosed a wave action electricity generation system **100** which includes a floating platform **101** that supports the system components in the surface of a body of water. According to *Rubi*, the system is allowed to freely float (as indicated by arrow **A1** in Figure 1) and rotate (as indicated by arrow **A2** in Figure 1) of the float on the surface of the body of water, and the wave motion causes a lifting on portion **102** of the platform (as indicated by arrow **A3** in Figure 3) or rotation of swivel means **206** (as indicated by arrow **A4** in Figure 3), which in turn causes the movement of the mechanical components of the system for electric generation.

9.2 The present invention is totally different from the teaching of *Rubi* as it operates upon a complete different principle. Rather than being driven by the motion of the water particles in the waves, the present invention device is driven by the pressure fluctuations under the surface of the water body.

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The present invention uses a float with excessive buoyancy tethered to the ocean floor by a tether that keeps the float beneath the ocean surface in spite of the excessive buoyancy. It also allows the float to move substantially horizontally in response to fluctuations in pressure in the region of the float. The buoyancy of the float creates a force **B** perpendicular to the isobaric surfaces of the ocean wave, while the tether creates a primarily downward holding force **T** on the float. As a result, the float is subject to a substantially horizontal force **F** which is a combination of the holding force **T** and the buoyant force **B**.

As the direction of the substantially horizontal force **F** changes back and forth in response to fluctuating pressure in the region of the float (which pressure fluctuation is associated with the waves of the water body, as slope of the isobaric surfaces changes which occurs when the ocean waves pass over the region where the float is moored), the float moves back and forth beneath the surface of the water, as shown in Figures 2A through 2D of the drawings of the '038 Application.

The present invention recognizes that the change in the pressure field under ocean wave propagation in ocean wave dynamics, as taught by *Tomczak* and *Dean et al.*, provides the fluctuation and change of direction of the resultant force acting upon the tethered float, which can cause the back and forth movement of the float, which movement in turn can be useful in applications of ocean energy conversion with the use of turbine devices, such as the Wells turbines taught by Professor Wells.

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9.3 These novel and unique characteristics and features of the present invention is discussed in detail in the Specification of the '038 Application, and further explicitly claimed in amended independent Claims 1 and 29 of the '038 Application. Particularly, amended Claims 1 and 29 of the '038 Application now claim that the float with excessive buoyancy is held in the water body ***beneath the surface of the liquid body*** and moves back and forth in a substantially horizontal direction as a result of a substantially horizontal force, which is a combination of the holding force and the buoyant force ***and changes its direction back and forth in response to fluctuating pressure in the region of the float that is associated with the waves of the water body***. This is totally different from the teaching of *Rubi* where the system is floating on the surface of the water and its movement has nothing to do with underwater pressure change.

9.4 It is therefore believed that the amended independent Claims 1 and 29 are not anticipated by *Rubi*, and consequently are allowable under 35 U.S.C. § 102(e) over *Rubi*. Claims 2–4, 22, 27 and 28 depend on independent Claims 1, and Claims 30, 31, 40 and 41 depend on independent Claims 29, respectively, and accordingly they are also believed to be allowable under 35 U.S.C. § 102(e) over *Rubi*.

10. The Examiner's rejection of Claims 16–21, 26 and 36–39 under 35 U.S.C. § 103 over *Rubi* in view of United States Patent No. 4,327,296 issued to Weyers (hereafter "*Weyers*") is noted but respectfully traversed.

10.1 Neither *Rubi* nor *Weyers* has disclosed the present invention wave energy conversion device that utilizes a float with excessive buoyancy and held in the water body beneath the surface of the liquid body where the movement of the float is caused by the pressure fluctuations under the surface of the water body. Accordingly, independent Claims 1 and 29 are allowable over *Rubi* in view of *Weyers*.

10.2 Claims 16–21, 26 and 36–39 depend on allowable independent Claims 1 and 29 respectively, and consequently are allowable under 35 U.S.C. § 103(a) over *Rubi* in view of *Weyers*.

11. The Examiner's rejection of Claims 5, 6–12 and 32–34 under 35 U.S.C. § 103 over *Rubi* in view of United States Patent No. 4,754,157 issued to Windle (hereafter "*Windle*") is noted but respectfully traversed.

11.1 Neither *Rubi* nor *Windle* has disclosed the present invention wave energy conversion device that utilizes a float with excessive buoyancy and held in the water body beneath the surface of the liquid body where the movement of the float is caused by the pressure fluctuations under the surface of the water body. Accordingly, independent Claims 1 and 29 are allowable over *Rubi* in view of *Windle*.

11.2 Claims 5, 6–12 and 32–34 depend on allowable independent Claims 1 and 29 respectively, and consequently are allowable under 35 U.S.C. § 103(a) over *Rubi* in view of *Windle*.

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12. The Examiner's rejection of Claims 13–15, 23–25 and 35 under 35 U.S.C. § 103 over *Rubi* in view of United States Patent No. 6,531,788 issued to Robson (hereafter "*Robson*") is noted but respectfully traversed.

12.1 Neither *Rubi* nor *Robson* has disclosed the present invention wave energy conversion device that utilizes a float with excessive buoyancy and held in the water body beneath the surface of the liquid body where the movement of the float is caused by the pressure fluctuations under the surface of the water body. Accordingly, independent Claims 1 and 29 are allowable over *Rubi* in view of *Robson*.

12.2 Claims 13–15, 23–25 and 35 depend on allowable independent Claims 1 and 29 respectively, and consequently are allowable under 35 U.S.C. § 103(a) over *Rubi* in view of *Robson*.

13. For the reasons stated above, it is submitted that all pending Claims 1–41 of the '038 Application are allowable either under 35 U.S.C. § 102(b) over *Rubi* or under 35 U.S.C. § 103(a) over *Rubi* in view of *Weyers*, *Windle* or *Robson*. Accordingly, reconsideration and withdrawal of the rejection of these pending Claims 1–41 under either 35 U.S.C. § 102(e) over *Rubi* or 35 U.S.C. § 103(a) over *Rubi* in view of *Weyers*, *Windle* or *Robson* are respectfully requested, and issuance of a Notice Of Allowance of all pending claims of the '038 Application is respectfully solicited.

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14. Should there be any issues remaining for the allowance of the amended pending claims of the '038 Application, the Examiner is respectfully invited to contact the undersigned by telephonic means before the issuing of a final office action.

Respectfully submitted,

Date: Sept. 11, 2023

Tony D. Chen
Registration No. 29,210

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U.S. PTO Briefing, Washington D.C.
August 11, 2003

Application No. 09/928,038
Tom Zambrano

# BACKGROUND BRIEFING

**METHOD OF AND APPARATUS FOR WAVE ENERGY CONVERSION USING A FLOAT WITH EXCESS BUOYUANCY**

Bart Hibbs, Tyler MacCready
Phil Tokumaru, Tom Zambrano

Tony D. Chen – Rozsa & Chen

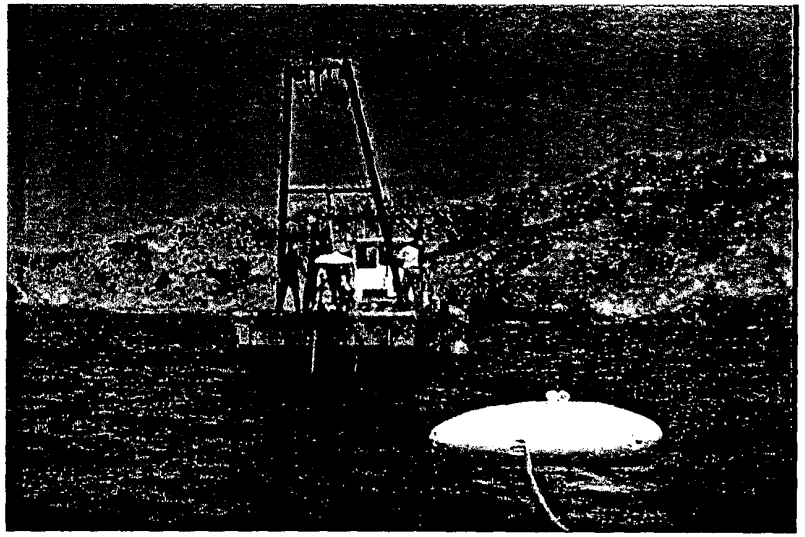

Photo of Proof-Of-Concept Float being towed to mooring location for undersea testing.

# TABLE OF CONTENTS

**Contrasting Wave, Water & Float Speeds**

**Application to Our Invention**

**Proof of Concept Experiments**
**(Video Presentation)**

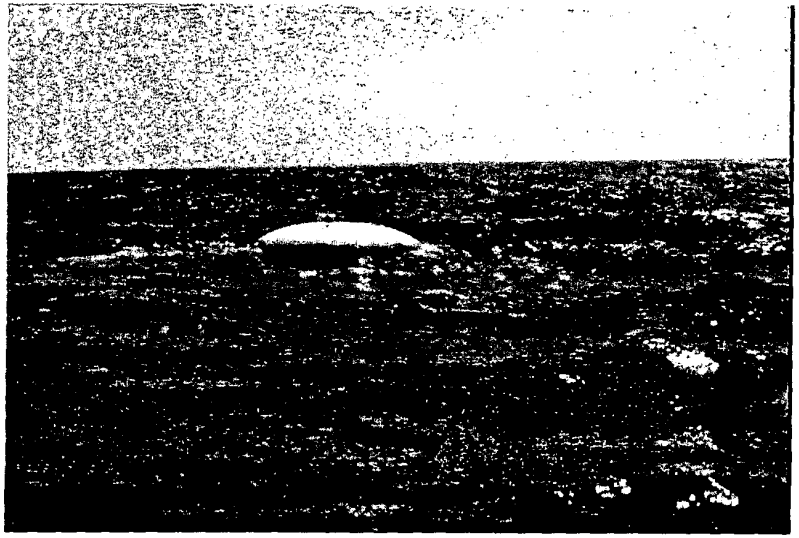

Photo of Proof-Of-Concept Float positioned over mooring to be submerged undersea by submerged winch attached to the sea floor.

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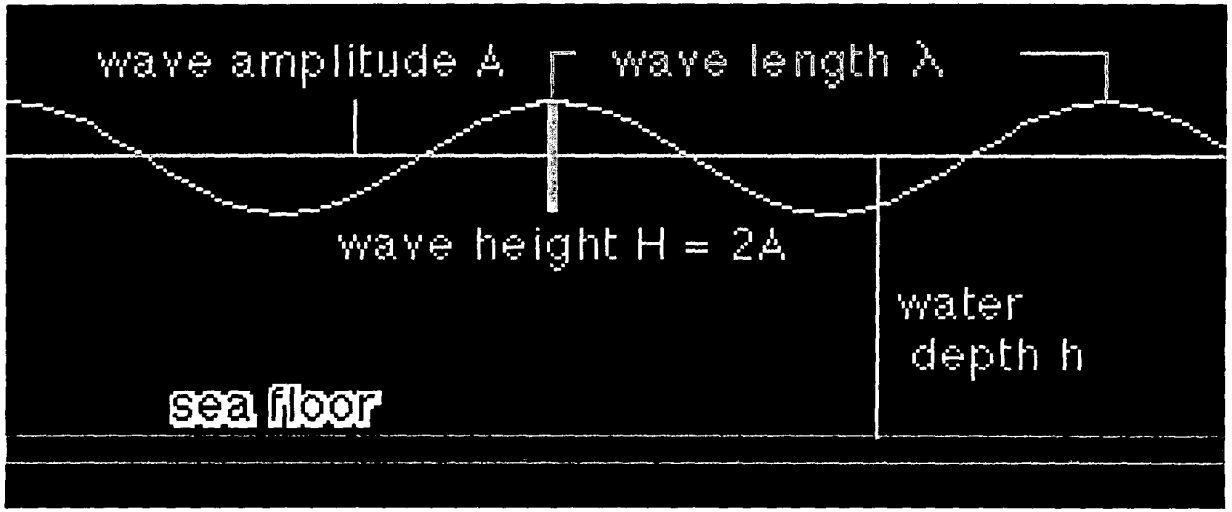
**WAVE SPEED (C)**

LENGTH ($\lambda$) - horizontal distance between two successive wave crests
HEIGHT (**H**) - distance between wave crest and trough (2A)
WATER DEPTH (**h**) – distance from sea floor to ocean surface
WAVE PERIOD (**T**) – time required for two successive wave crests or troughs to pass a single point

**h > $\lambda$ /4 then C = 1.56 T in m/sec**

Sketch of a harmonic or ideal sinusoidal wave.
H is exaggerated against L for clarity

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Reference: Tomczak, Matthais: "Introduction to Physical Oceanography, Version 2, University of South Australia, Adelaide. September 2000

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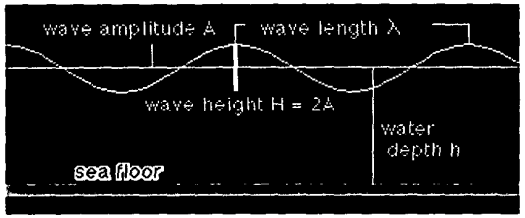
## SAMPLE CALCULATION -- WAVE SPEED

For




Typical Ocean Wave period of 8 seconds ( T =8)
Typical Ocean Wave Height of 3 meters (H=3)
Typical Ocean Depth of 50 meters (h=50)

Wave Speed

$C = 1.56 (8) = 12$ m/sec.

---

Note: This also means that the wave length ($\lambda$) is 100 – m, since a typical ocean wave with an 8 second period travels at the speed of 12.5 m/sec.

## WATER PARTICLE SPEED (W)

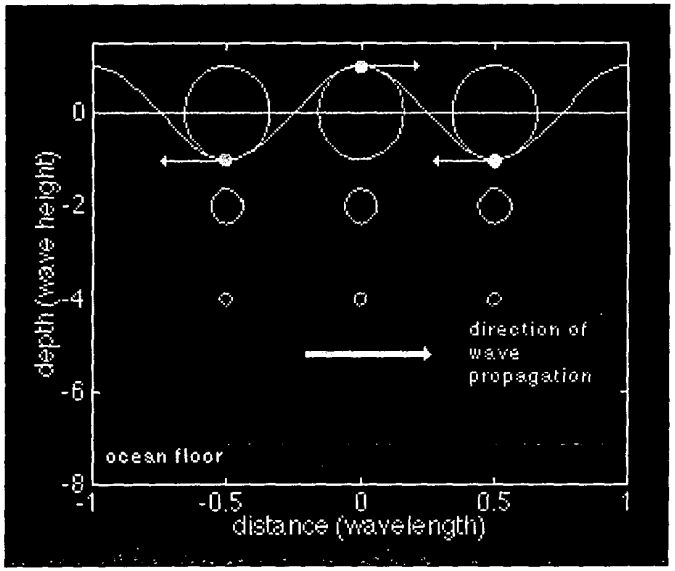
Water molecules within waves travel in circular motion.

Water molecules do not translate in the direction of the wave.

Water molecules travel one circumference per wave period

$$W = \pi (H) / T$$

Sketch of particle movement in deep water waves. The diagram is vertically exaggerated for clarity.

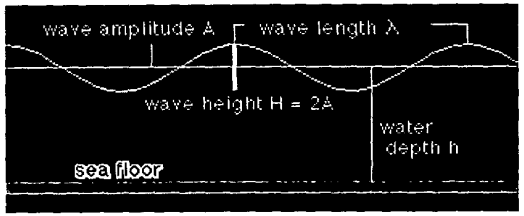


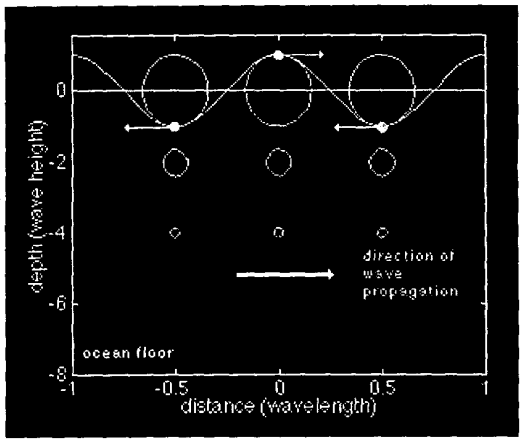

Reference: Tomczak, Matthais: "Introduction to Physical Oceanography, Version 2, University of South Australia, Adelaide. September 2000

## SAMPLE CALCULATION (CONT.) -- WAVE SPEED AND WATER SPEED

For

Typical Ocean Wave period of 8 seconds ( T =8)
Typical Ocean Wave Height of 3 meters (H=3)
Typical Ocean Depth of 50 meters (h=50)




Wave Speed
$C = 1.56\ (8) = 12$ m/sec. $(\lambda = 100$ –m)

Water Speed
$W = \pi\ (3) / (8) = 1.2$ m/sec. (near the surface)

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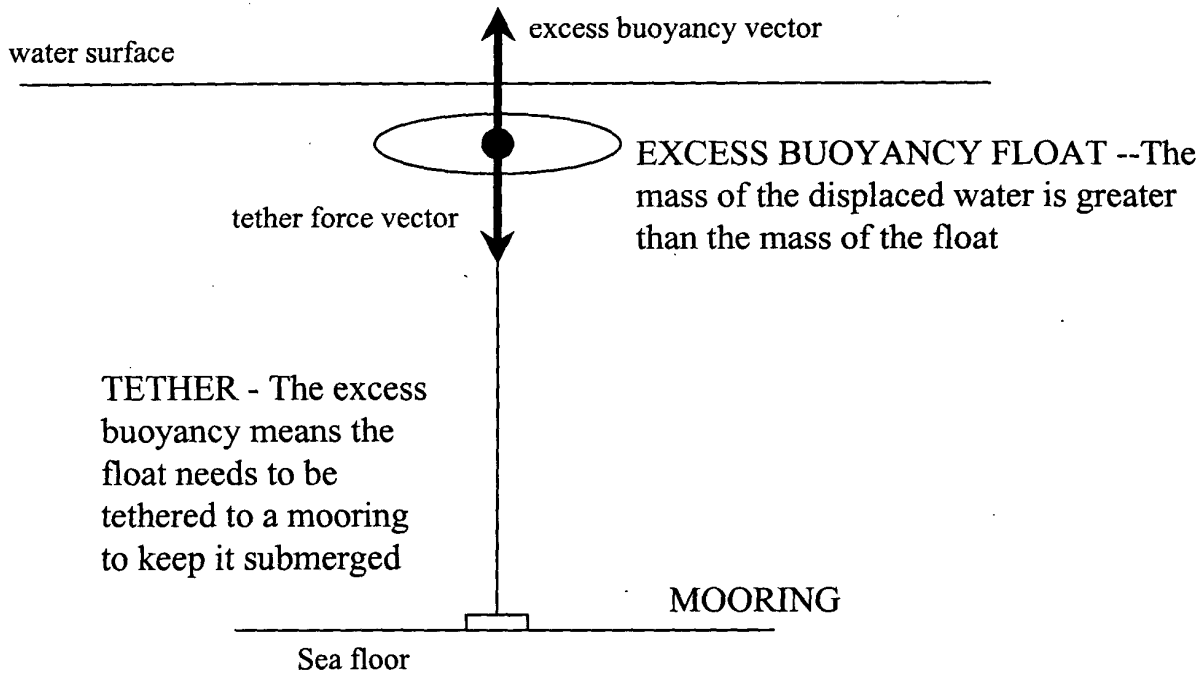
**TETHERED FLOAT WITH EXCESS BUOYANCY – STILL WATER ( NO WAVE MOTION )**

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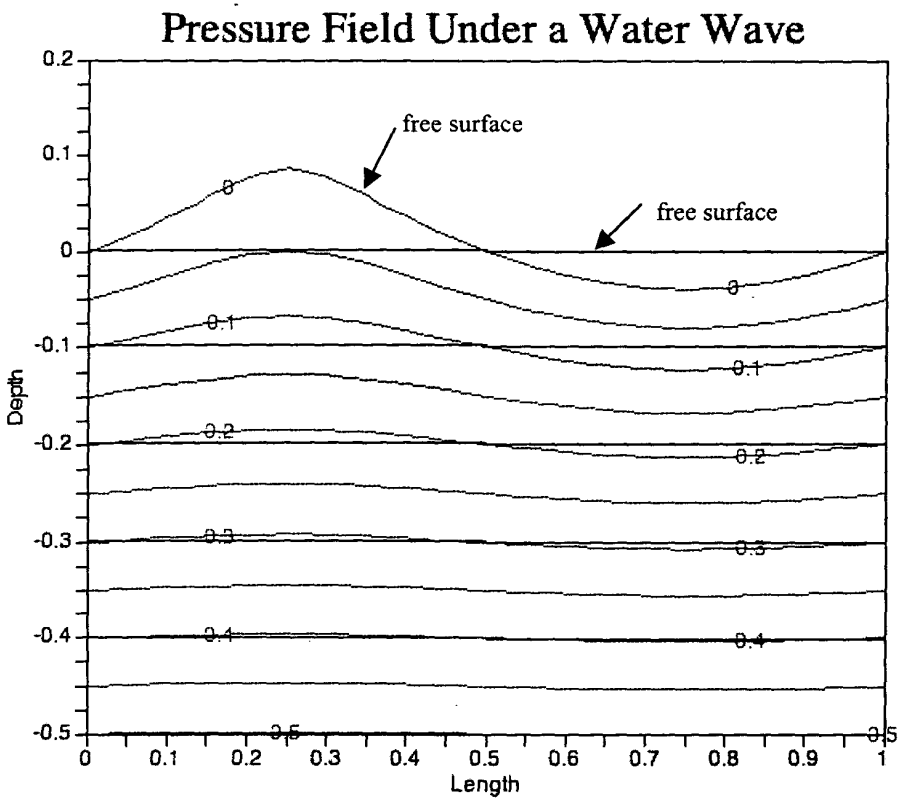
Note: Excess Buoyancy Vector *Always* Perpendicular to the Water Surface

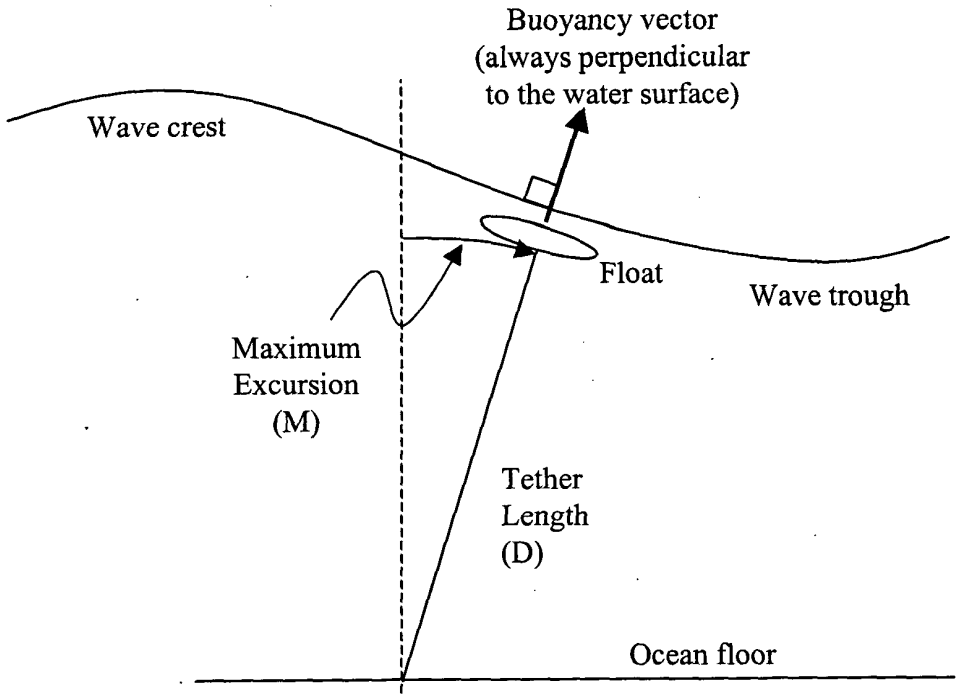
Sketch showing lines of constant pressure as a function of depth below the free surface for **No Wave** and **Wave** conditons.




Pressure Gradient (No Waves) = Hydrostatic Pressure Only
Pressure Gradient (Waves) = Hydrostatic Pressure + Surcharge of Pressure Due to Free Surface Displacement
+ Vertical Acceleration.

Reference: Dean, Robert G., and Dalrymple, Robert A., "Water and Wave Mechanics for Engineers and Scientists – Advanced Series on Ocean Engineering – Vol. 2, Prentice Hall, Inc. 1984

## TETHERED FLOAT WITH EXCESS BUOYANCY – WITH WAVES




Maximum Excursion (M) Depends on the Maximum Wave Slope and the Length of the Tether (D).
Assuming Sinusoidal Wave $M = \pi(H/\lambda)\, D$

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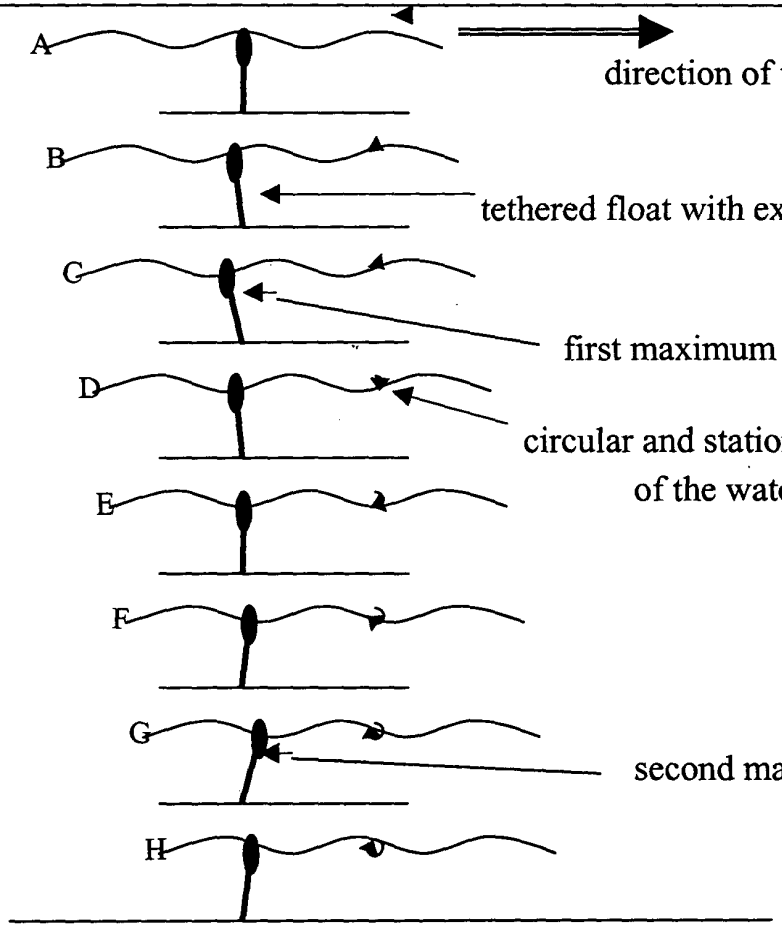
Sketch Showing Wave Motion, Water Particle Motion and Float Motion Through 8 Steps of a Single Wave Cycle

NOTE : Through One Complete Wave Cycle the Float Travels the Maximum Excursion Distance (M) Four Times

FLOAT SPEED = 4(M)/T




direction of the wave propagation

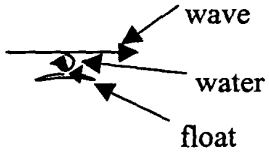
tethered float with excess buoyancy

first maximum excursion of the float

circular and stationary clockwise path of the water molecules

second maximum excursion of the float

These vectors summarize the relative motions outlined in A – H.




The float moves back and forth *through* the water rather than with the *water*

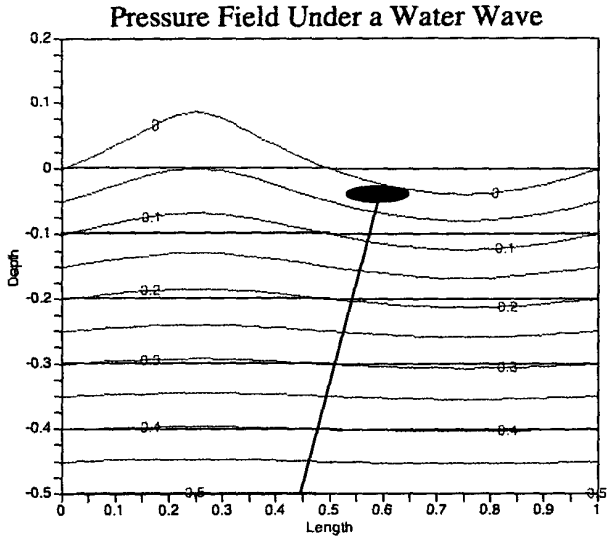
## SAMPLE CALCULATION -- WAVE SPEED. WATER SPEED & FLOAT SPEED

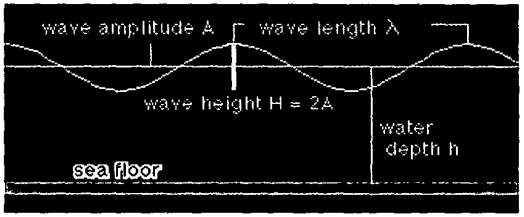
For
T = 8-sec
H = 3-m
$\lambda$ = 100-m
D = 50-m

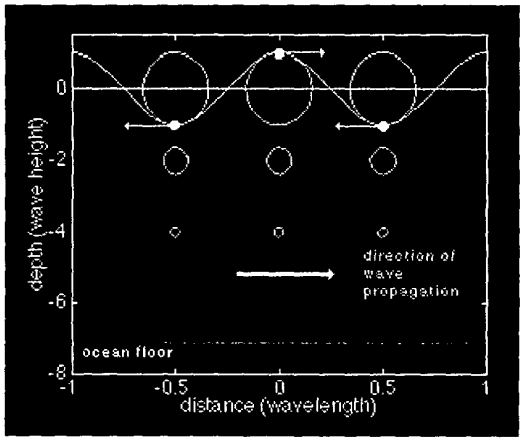
<u>Wave Speed</u>
C = 1.56 (8) = 12 m/sec.

<u>Water Speed</u>
W = $\pi$ (3) / (8) = 1.2 m/sec.

<u>Float Speed</u>
F = 4(M)/T = 4{$\pi$(H/$\lambda$)D}/T
= 4 {$\pi$ (3/100)50}/8
= 2.4 m/sec



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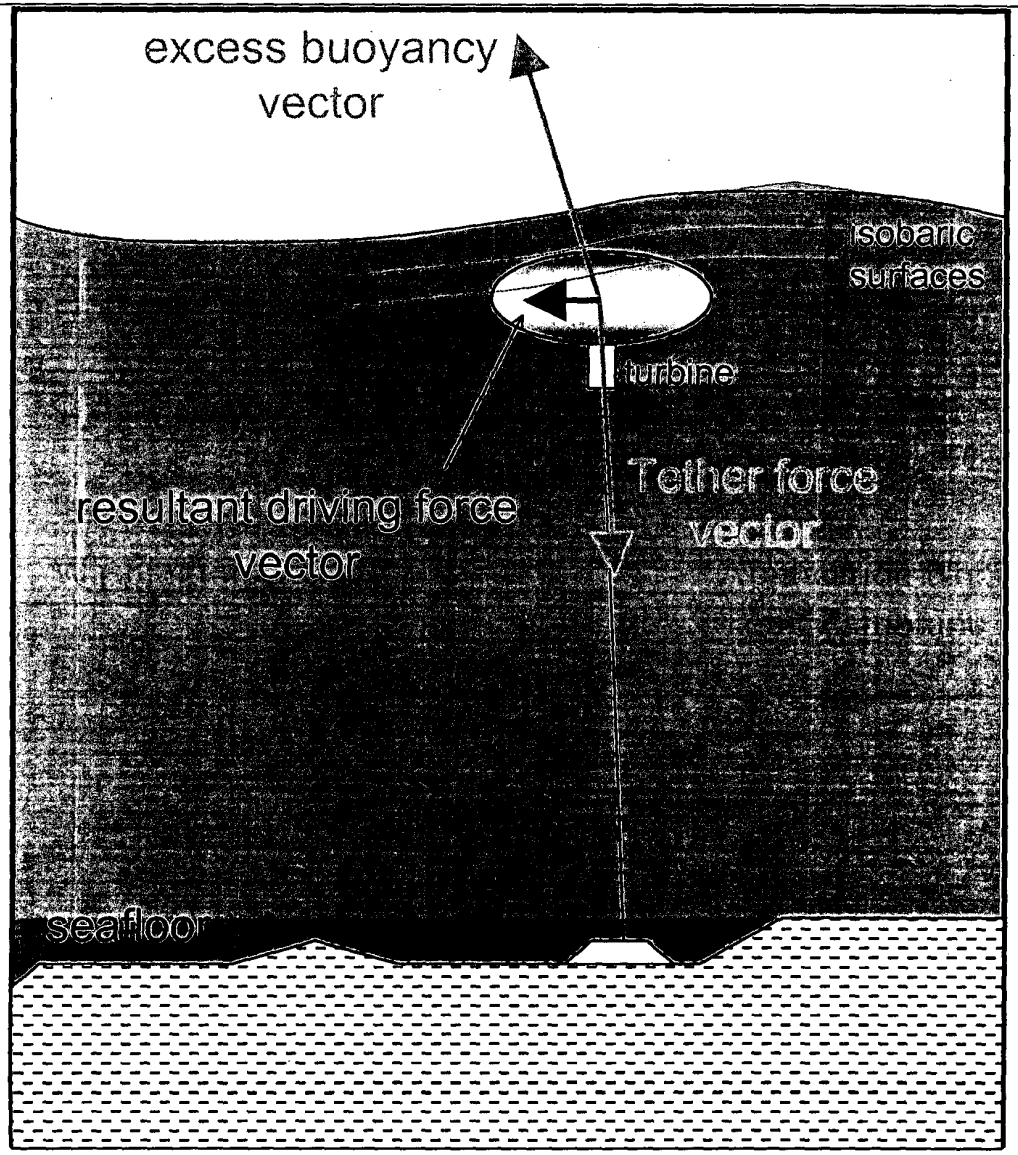
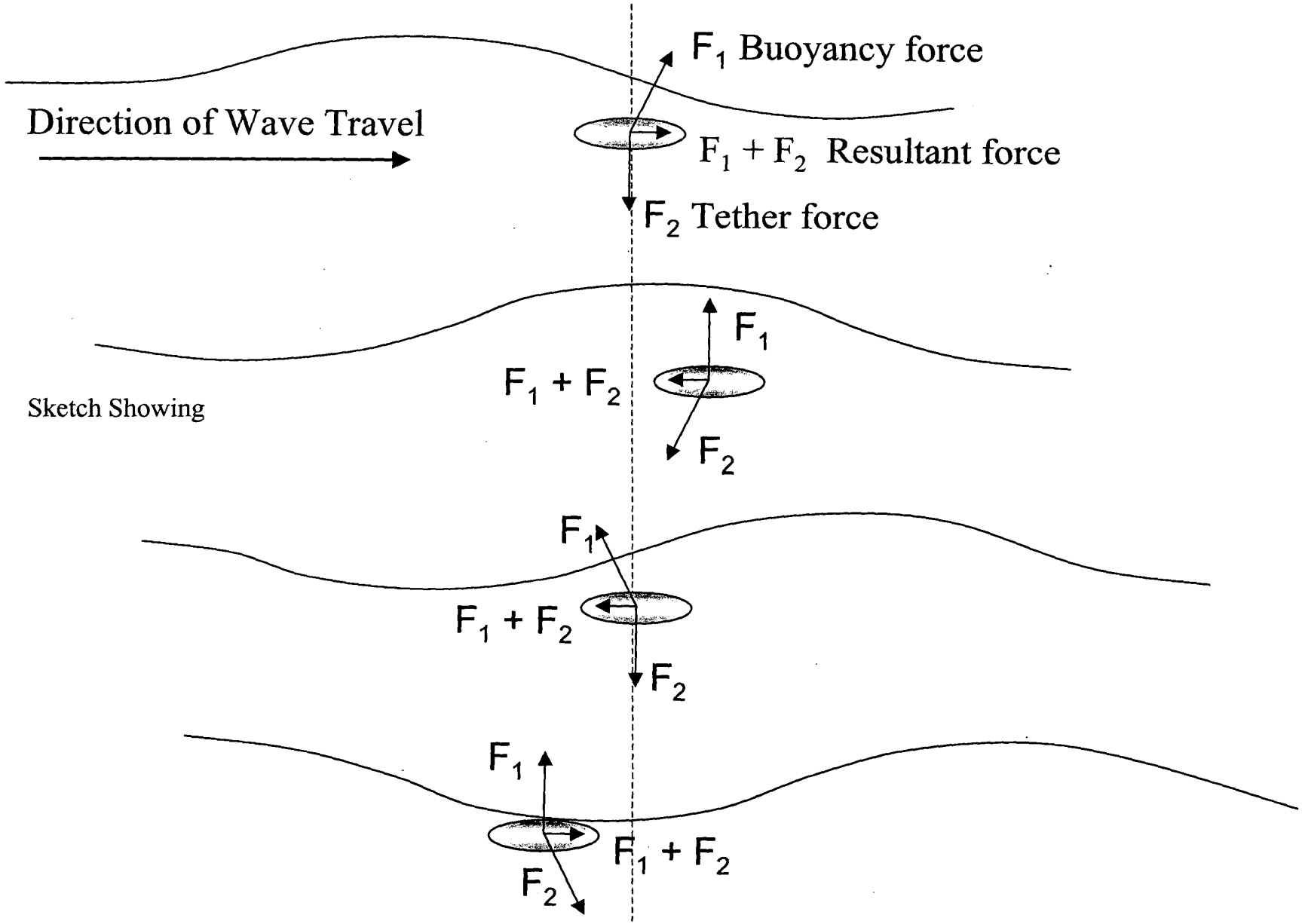
A device designed to extract energy by slipping through the water by the pressure gradient will be different than a device designed to extract energy heaving and pitching with the circular motion of the water particles.




Our device is a streamlined body with excess buoyancy tethered beneath the ocean surface optimized for the speed of its horizontal movement in response to oscillating pressure gradients associated with passing waves,

THE RESULTANT FORCE TO BUOYANCY AND IT'S VARIABILITY THROUGH A WAVE CYCLE




Sketch Showing

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## SUMMARY

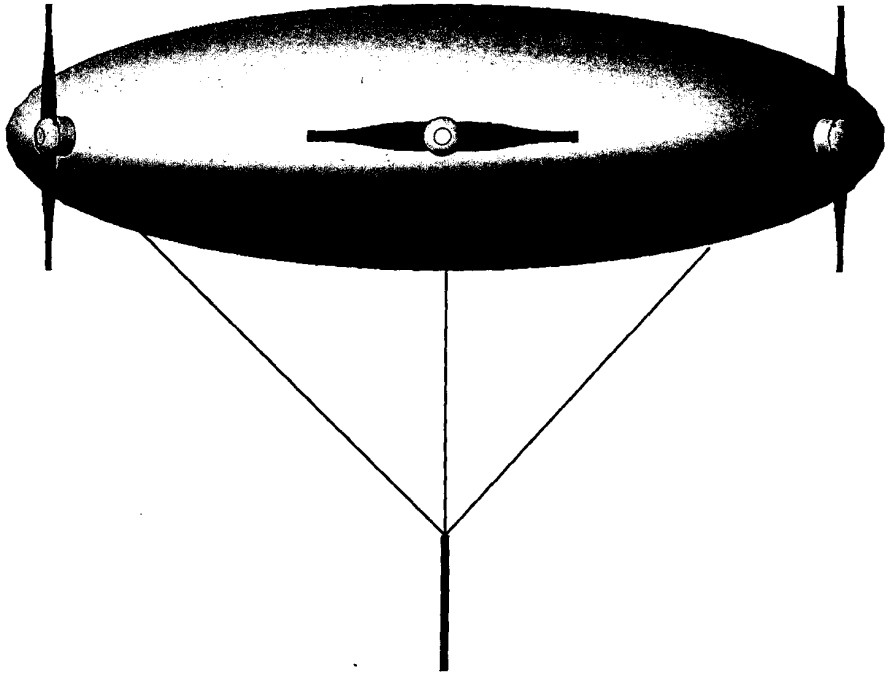
Wave Motion is an Order of Magnitude Greater Than Others and is Unidirectional

Water and Float Motions are Both Cyclical but Distinct -- Often Traveling in Opposite Directions

The Horizontal Movement of the Float *Through The Water* Offers Our Opportunity to Extract Energy from a Hydrodynamically Optimized Device.

We refer to our device as a NAF, which is an acronym for Non-Archimedean Float, to emphasize the roll of the excess buoyancy vector

For Proof-Of-Concept We Designed A NAF and affixed several propeller-generators to the float to show we can get useful work out of this motion



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**VIDEO PRESENTATION OF PROOF-OF-CONCEPT**

- All testing is conducted in the open sea, exposed to real waves and weather
- First tests were with a small generator-light assembly that blinked as the NAF translated horizontally through the water
- First tests included flow visualization of movement via underwater cameras held by divers, note the relative movement of the NAF with that of the divers
- Brief explanation of numerical modeling of the phenomena, and design of a NAF to gather quantitative velocity, acceleration and power extraction data.
- Brief views of the shop, including fabrication of the NAF and an undersea remote control winch bell so we could control depth of NAF placement.
- Deployment of NAF including propeller turbines to extract energy speed of its horizontal movement in response to oscillating pressure gradients associated with passing waves.
- Underwater sequences, noting the acceleration and deceleration of the propeller generators affixed to the side of the float and the velocimeters affixed to the top of the float

Total run time – approximately 13 minutes

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# REFERENCE LIST

FIG.5A

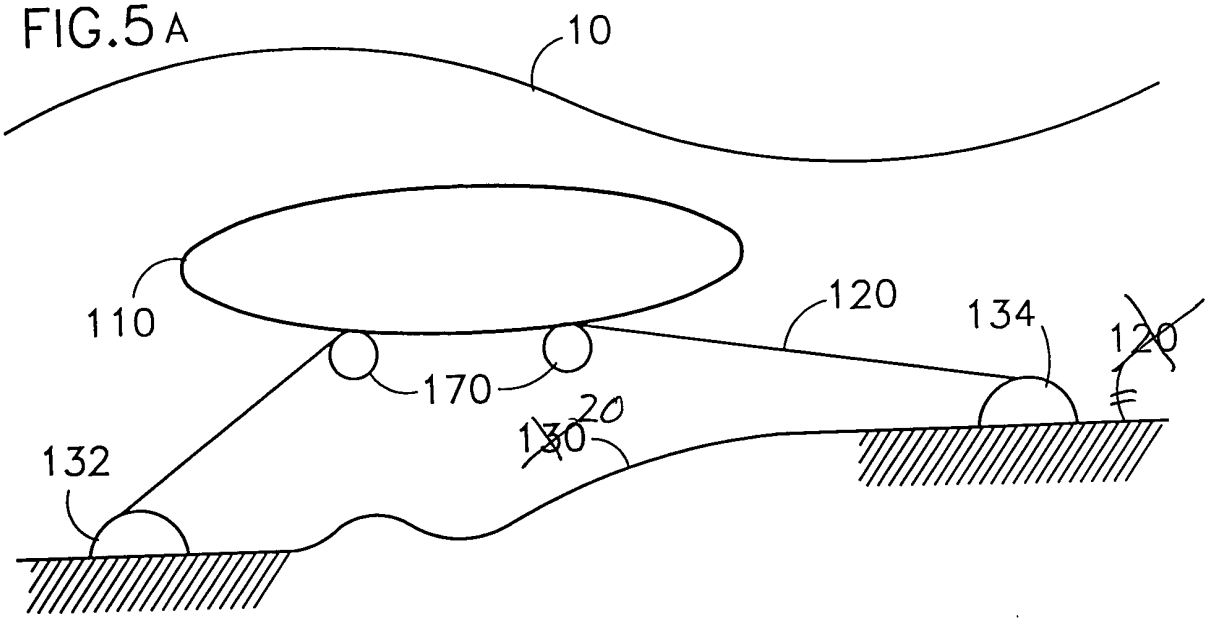



FIG.5B

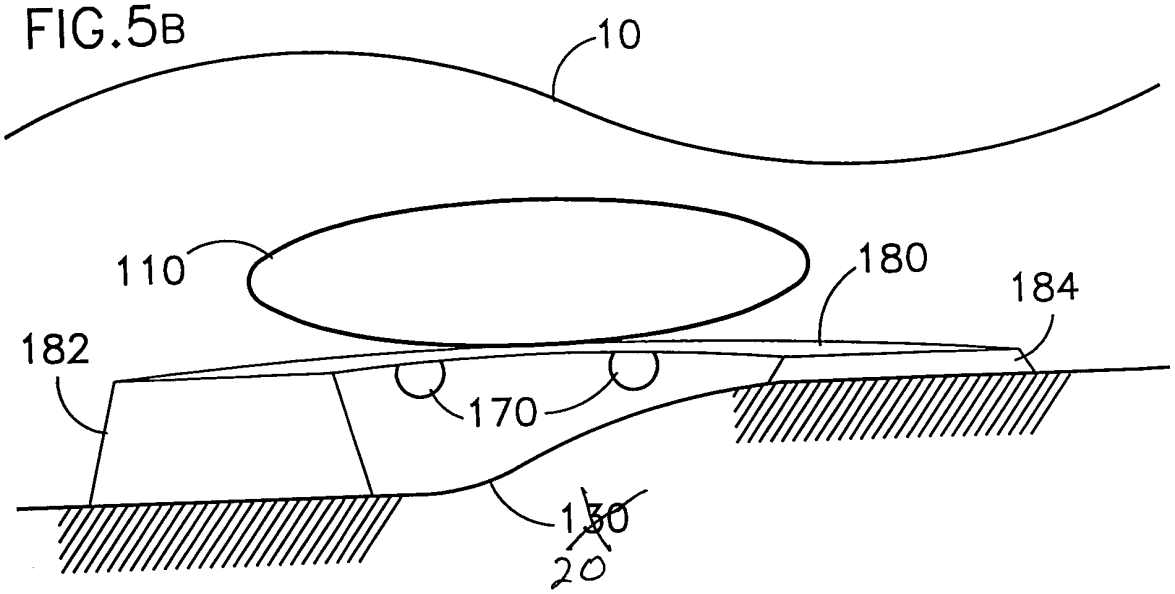


FIG.3 A

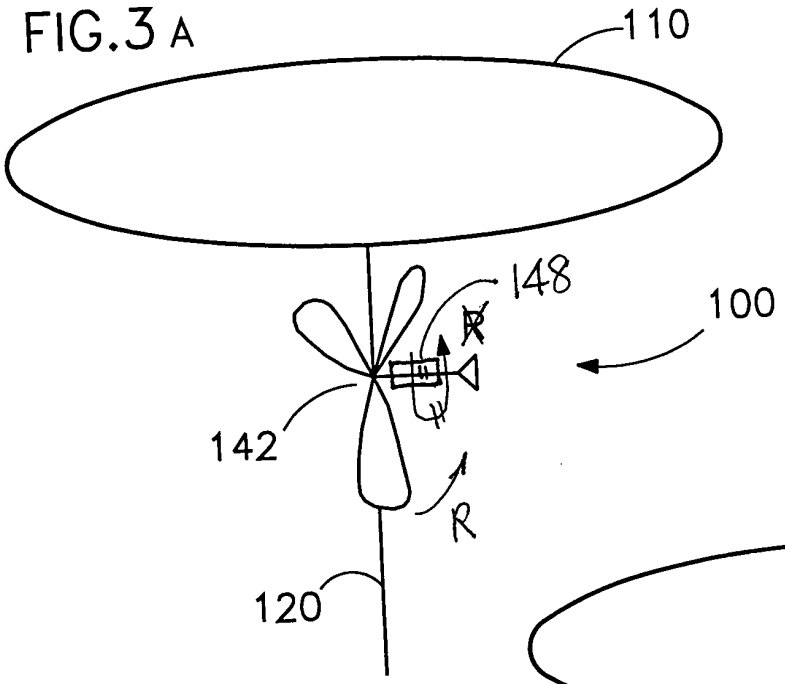



FIG.3 B

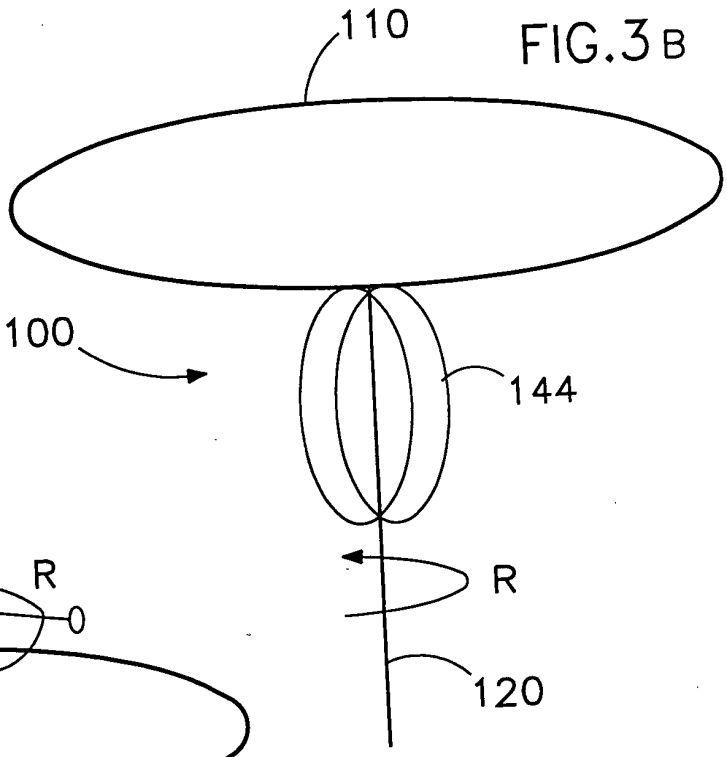



FIG.3 C

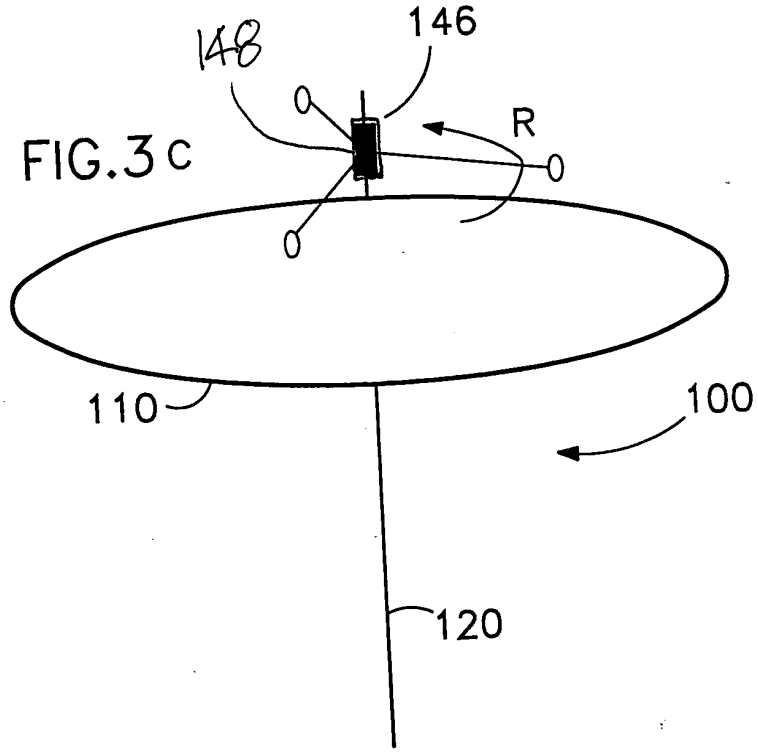
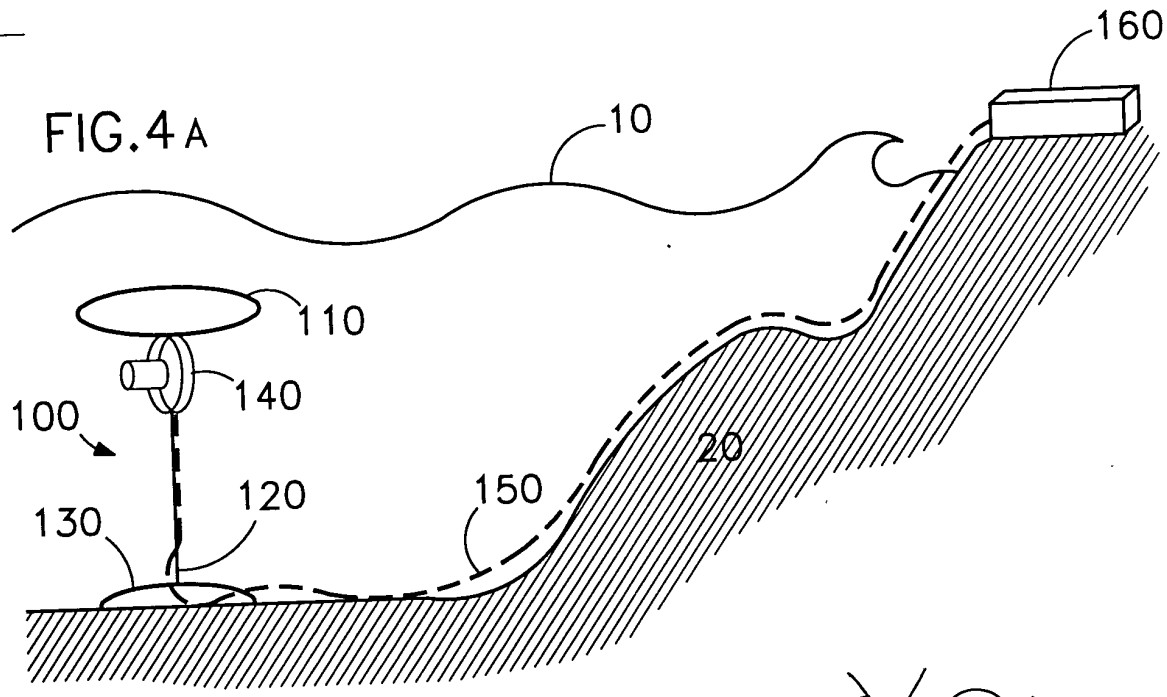


FIG. 4 A



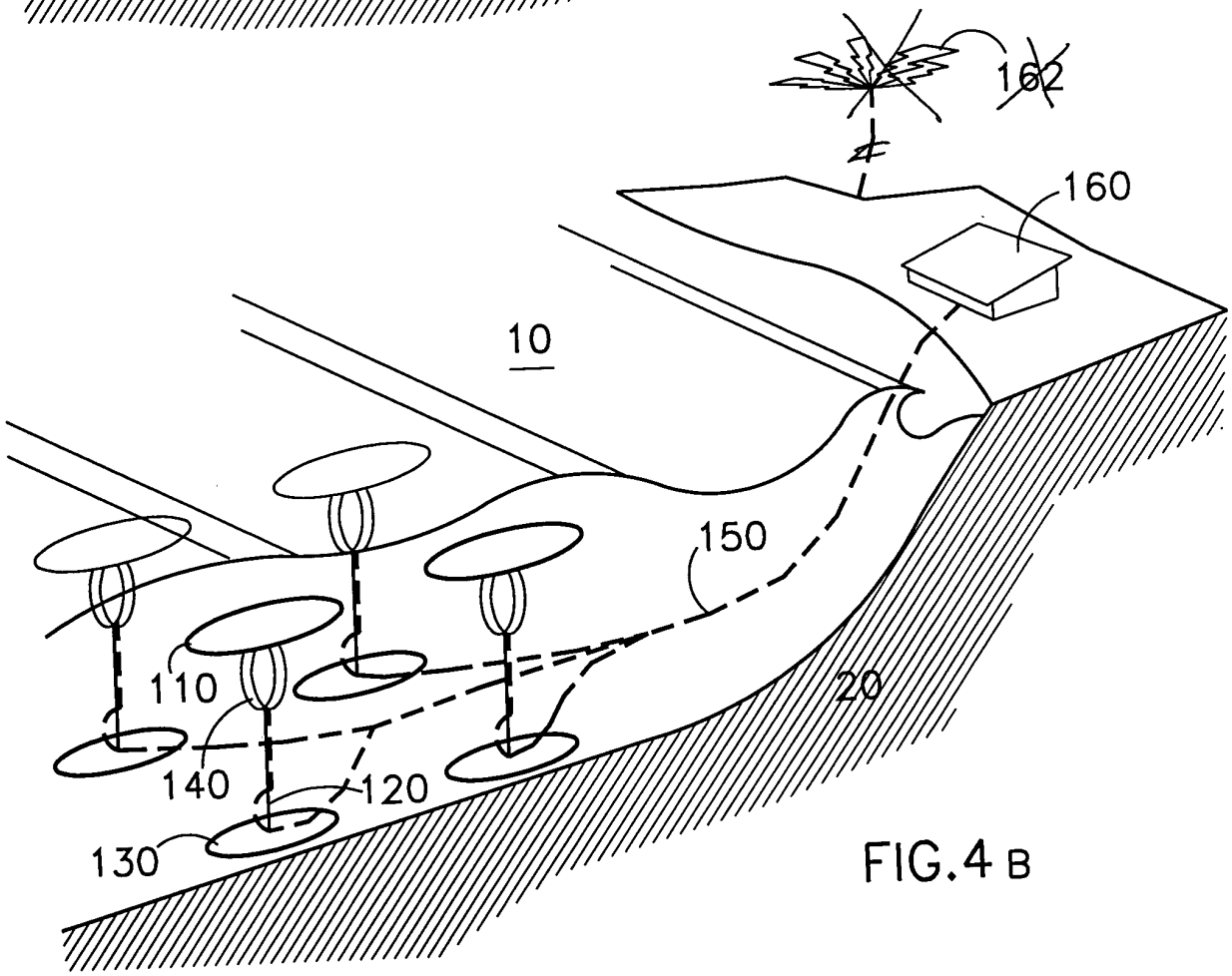




FIG. 4 B